SECS Senior Design
Available Projects – Winter 2023

Stamping Die Temperature Sensor

Sponsor: Sergey Golovashchenko (golovash@oakland.edu)

This effort is addressing the major need in the automotive industry to minimize variability in stamped sheet metal components such as doors, hoods, decklids, fenders, etc. The typical deviation in dimensions of panels accepted by the automotive industry is within 0.5 mm for outer skin panels and 1mm for interior panels. With the general trend to make cars and trucks lighter and use more advanced Ultra High Strength Steels and Aluminum Alloys, the dimensional stability in sheet metal stamping becomes a more significant challenge. Even though all parts coming from a stamping line seem to be the same, there are phenomena such as die wear, variability in properties of sheet metal, non-uniform lubricant distribution on the surface of the blank, and accumulation of dust type particles separating from stamped panels and landing on the surface of stamping dies. The project targets development of sensor-based technology which would be able to capture significant deviations from normal stamping conditions in production dies.

The general concept is to develop a sensor design suitable for measuring local temperatures in stamping dies. The development will include the following steps:

1) design and validate the method of measuring temperature near the working surface of an insert imitating the stamping die.

    a) select sensors, a data acquisition system, and a sensor mounting method with sufficiently small inertia to capture temperature changes in the stamping die;
    b) construct the system which can physically simulate the heat transfer process to the die by placing preheated blanks for the duration of a stamping cycle between two clamped inserts and monitoring the temperature of the inserts;
    c) perform theoretical analysis of heat transfer using a one-dimensional approach and compare the results of calculation with experimental results on temperatures of inserts;

2) perform experiments on measuring insert temperature while pulling the strip between two clamped inserts inside the drawbead simulator with the assistance of Sheet Metal Forming lab researchers;

3) fabricate the insert incorporating temperature sensors for the existing U-bend stamping die and perform temperature measurements during forming strips in drawbead simulator or stamping on a 60-ton mechanical press at the OU

Incubator with assistance from the press operator and Sheet Metal Forming lab researchers.

The resources to purchase the material for designed components and to purchase necessary off-the-shelf parts will be provided by the OU Center of Advanced Manufacturing and Materials.

NOTE: Confidentiality and assignment agreements are required before students can begin work on this project

Vehicle Parking Space Monitoring System

Sponsor - Diversified Engineering Concepts, LLC
Sponsor Liaison: Dr. Phares A. Noel II, Ph.D., PE (panoel@oakland.edu)

The goal of this effort is to develop a device that will be able to indicate when a predetermined number of parking spaces are occupied by automotive vehicles.

This will be accomplished by utilizing an inductive loop sensor which will monitor the inductance of a loop of wire that has been embedded in the surface of the parking area in such a way as to intersect a predetermined number of parking spaces. See Figure 1

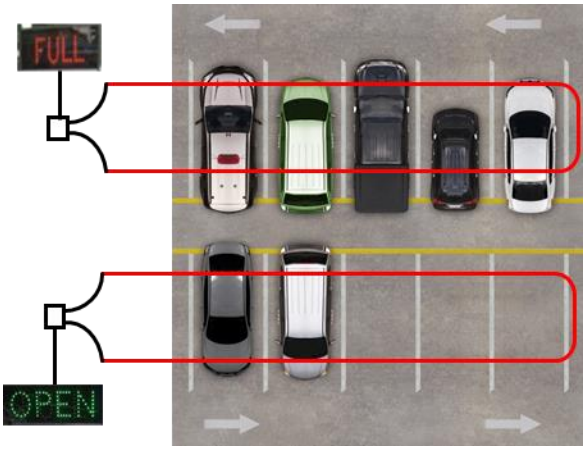

Figure 1

When all the parking spaces are occupied, the system will trigger a sign to indicate that the available parking spaces are full. Whenever the monitored space is not full, the system will trigger a sign to indicate *Open* which will imply that there is at least one available space in the monitored area.

This will be achieved by having the inductive loop sensor to monitor the loop's inductance, which changes as vehicles enter the loop. When the loop's inductance exceeds a predetermined threshold value that correlates with the maximum number of

vehicles within the loop, the sensor will trigger an output to indicate that all parking spaces are occupied.

After all spaces are occupied, when any vehicle exits the loop, the loop inductance will rise above the full loop threshold which will indicate that a space is available. See Figure 2.

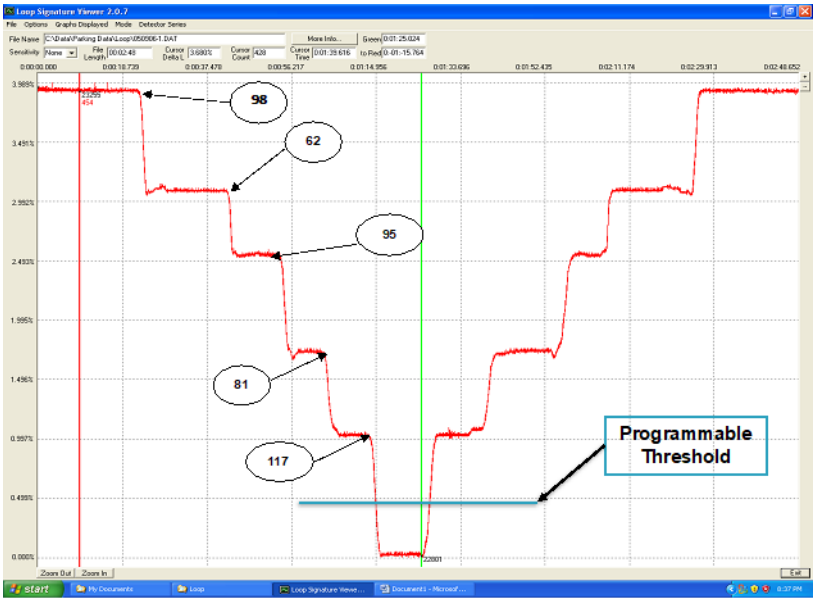

Figure 2

Goals and Expectations:

- The intent is to develop a full-scale prototype design utilizing a commercially available microcontroller development system, whereby the hardware architecture can be readily adapted for mass production.
- The system should be able to accommodate 10 typical parking spaces, which amounts to a loop length of 150 feet, with the ability to scale to at least 20 parking spaces or more.
- Initially the system should have the ability to handle a range of automobiles from those considered small (Fiat 500) to a full-size heavy-duty truck (Ford F350).
- Initially during development, utilizing a wire laid on the surface of a parking lot will suffice. Once development has progressed to a certain point, the system will be tested with a loop that is currently installed in an existing parking lot.

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Medication Dispensing System

Sponsor: Therapeutics Technology Solutions (TTS)
Liaison: Maurice Reeves (mjr@thpx.me)

This project will evolve the development of a patent-pending medication dispensing system to combat opioid addiction. This system aims to ensure that medication used to treat opioid addiction is not misused or sold illicitly. While this medication has therapeutic properties, it can also be fatal if improperly consumed. This system programmatically limits access to specific dates and times and uses biometrics to prevent children and unauthorized individuals from accessing these dangerous pharmaceuticals. Refer to Controlled Substance Management Device video – https://vimeo.com/535724209.

Design team(s) will create an Internet of Things (IoT) device that interfaces with a cloud-based software platform. This radically new design must meet design requirements, including provisions for 14 doses, biometric ID access, a minimum number of failure points, and durability for use in the consumer market desired manufacturing cost points.

Existing features:
• Biometric ID Access (fingerprint) to prevent unauthorized access.
• Ability to dispense only a single dose of medication in a designated time period.
• Wi-Fi communication to enable local internet access

New features:
1. GPS capability to enable tracking
2. Cellular communication capability for programming and transmission of device status.
3. Camera and microphone capability to enable video and voice communications.
4. Tamper-resistant enclosure to prevent unauthorized access, while tracking entry attempts

Therapeutics technical resources will be readily available to collaborate and support team research with background information on the current device capabilities and features. In addition, we shall share lessons learned, and clarify development needs and requirements as needed.

NOTE: Confidentiality and assignment agreements are required before students can begin work on this project

Crumb Rubber Rail Tie

Sponsor: AirBoss Flexible Products
Liaison: Jeff Auten (Jeff.Auten@airboss.com)

- Benchmark consumer and/or commercial products in the market where sustainable materials are or could be potentially used (namely crumb or recycled rubber).
- Design and develop a representative concept or component employing the sustainable material and the process steps necessary to manufacture the product on a mass production scale.
- Use both Airboss and Oakland University testing capabilities to evaluate material properties and design concepts against any available market data or engineering targets.

Existing Rail tie:

- 8.5 ft x 9 in x 7 in
- Composed of wood

Crumb Rubber Rail Tie:

- 8.5 ft x 9 in x 7 in
- Composed of recycled rubber. Rubber is shredded and processed into crumbs. Crumbs are then mixed with binders and bonders. The compound is then compression molded into a rail tie.

Expected Deliverables:

- Benchmark Data (Product Type & Market Cost) – “Best in Class vs Lowest Cost” (Presentation document)
- Student Design Concept based on Benchmark Data (CAD drawings & Models)
- Process Plan supporting prototype and mass production (PFD)
- Cost to Market evaluation – (Excel Cost Sheet)
- Scaled prototype part manufactured at Airboss Facility (timing to be presented to consider meeting course requirements)
- Demonstrate functional competitiveness (Design and Cost) vs. current market (testing may require “scaled” approach if 1:1 scale part cannot be generated. (Presentation document)

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System for Purifying Liquids

Sponsor and Liaison - Ljeon Cacevic (cacevlje@umich.edu)

The intent for this Senior Design Project is to analyze, design, build, and test a system that uses a novel technique to purify liquids.

The system aims to purify polluted and/or salinized liquids into clean water using solar energy to heat the polluted/salinized water, evaporate it, condense it into purified liquid, capture, separate, and store it safely for different uses. The goal throughout the project's design, building, and testing phases is to maximize system efficiency, or the rate of purification.

The parameters to consider are simplicity, scalability, and a minimal environmental footprint. Simplicity is roughly defined as ease of producing and using the project. Scalability is defined as the ability of the project to scale the system for lower or greater purification capacity. A minimal environmental footprint is defined as a project that deploys this system with minimal waste of the natural resources it uses. All designs and prototypes that conform to the parameters of this project are acceptable.

Testing and results that meet our goal of maximum rate of purification will help us move one step closer to bring this system to market and potentially significantly lower the costs of liquid purification, and therefore, increase access to clean water for households, agriculture, and communities around the world.

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Challenge - Autonomous Steel-Column Climbing Robots

As an example of the utility of robots for inspection in dangerous places, small autonomous robots will be developed that will start on the floor of the SDL at a starting line, make their way to the large steel column in the center of the south wall, climb the column, ring a bell at the top, climb down the column and return to the starting line.

Safety and speed are the main challenges of this task. Wireless video cameras should be incorporated into the device if it can be done without sacrificing either safety or speed. The device must be able to complete the entire task without human interaction. No device will be allowed on the steel column without first demonstrating its safe operation to the instructors.

Each group will be reimbursed for costs; the budget for the project will be determined through the project proposals.

At the end of the semester, all the groups developing these robots will compete against each other. Scoring will consist of the time required to complete the task, divided by the cost of the device.